Chapter 5. Monitoring and Adaptive Management

Monitoring denotes the process used to evaluate progress toward the stated goals in the management plan for JDSF. Adaptive management denotes the management strategies that will be implemented if analysis of monitoring results indicate that resource conditions begin to deviate from the desired trajectory. This chapter describes the monitoring and adaptive management approach that will be used on JDSF in the implementation of this management plan. This chapter also provides a brief account of past and current monitoring activities.

The JDSF Approach

The scientific literature commonly recognizes five categories of monitoring: inventory and baseline assessments, trend monitoring, implementation monitoring, effectiveness monitoring, and validation monitoring. Rather than advancing the science of monitoring, this management plan focuses on practical implementation of proven, practical monitoring strategies that can be sustained given limited budget and personnel. Monitoring in this manner is an important objective in demonstrating applicable forest management methods. Consequently, this plan adopts a simpler approach to monitoring, consisting of defining monitoring goals, parameters and data collection, and analysis and adaptive management. The five categories of monitoring above are all represented in the JDSF approach, albeit in a more aggregated fashion.

Monitoring goals describe the desired future conditions we try to achieve on the Forest, or the forest structure we are trying to achieve. These goals are summarized in the implementation guide below, and described in more detail in Chapter 3 of this document. The desired future conditions may well become constantly moving targets, as societal preferences, biological conditions, and scientific knowledge change with time. This plan will be updated to reflect such changes.

Parameters are the variables that will be measured under the monitoring program. To a large extent, defining monitoring parameters equate to formulating the hypotheses or questions necessary to be able to collect relevant data and evaluate whether we are on track to achieving desired forest conditions.

The final step, analysis and adaptive management, refers to the process of evaluating the data and reaching results and conclusions regarding forest conditions and trends over time. Analyses can range from data summaries coupled with professional judgment in the case of high levels of uncertainty and lack of data, to formal statistical tests of hypotheses addressing issues of sampling variation where such data is available. The conclusions from the analysis stage form the basis for adaptive management strategies.

Resources available for monitoring are limited whereas the potential parameters that could be monitored are infinite. Since we cannot monitor everything, this management plan focuses on ecosystem vital signs–parameters that are statistically robust, inexpensive to obtain, and are key to providing reliable early warning signals of changes in the structure and function of the Forest. In addition, monitoring goals are ranked into two priority categories. This approach will enable managers to determine which goals will be addressed in any given year, given budget and personnel limitations at that time. This monitoring strategy may not keep track of all important parameters at all times. Due to its flexibility however, it enables the State Forest to sustain an uninterrupted program of tracking forest conditions over time, detect major changes and adapt management practices in response.

The collection of baseline data within the Forest boundaries is important for some monitoring needs. By extending certain monitoring activities outside the Forest to address larger issues, we may most efficiently use limited resources. For example, botanical surveys along transects from the coast to the dry interior and across different ownership classes would provide data for multiple purposes. This would provide baseline data within the forest for adaptive management uses and research data for contrasting biodiversity by ownership class and ecotype. To efficiently allocate limited resources and fulfill our

research and demonstration mission, we will consider other questions and objectives when developing data collection strategies for monitoring.

The timing of monitoring data collection and adaptive management analysis varies by topic. The list below summarizes the frequency of certain activities.

Continuous

- Pest and invasive weed infestation monitoring
- Forest operations
- Heritage resources (training, JDSF database, post fire, road segments)
- Management plan updates (separate from 5-year review)
- Rare plants and animals using survey and the California Natural Diversity Database
- Climate data
- Forest protection and security
- Forms of recreational use

Periodic

- Road and drainage features, more frequent in winter
- Forest inventories
- Short-term harvest schedule, and long-term plans
- Species abundance and health
- Botanical surveys for timber harvesting plans and other large projects
- Floristic surveys in some areas to gain a better understanding of the relationships between the local plants, their distribution, and their habitats.
- Research installations

Annual

- Active road inspections
- Recreational and minor forest product collection trends
- Production of forest products
- Vegetative changes due to management activities

A process for evaluating monitoring information in the context of the management plan will occur to coincide with the 5-year review of the plan by the Board. Advisory entities will be used to provide recommendations on monitoring approaches and to assist, where appropriate, with the interpretation and evaluation of monitoring information before the Board review.

Implementation Guide

The rest of this chapter will describe the specific application of the JDSF monitoring and adaptive management approach to the full range of resources on the Forest, covering both ongoing and planned future monitoring efforts. This implementation guide is intended primarily as a field manual for the forest manager, to guide in implementation of the JDSF monitoring approach on the ground. It is therefore organized in a series of steps, listing monitoring priorities for each resource, followed by parameters and data to be collected, and finally analysis approaches and adaptive management strategies.

Forest Resources

Maintain a wide range of seral stages. Increase late seral (CWHR 5 and 6) forest conditions.

Non-declining inventory levels. Harvest less than growth over any rolling 10-year period. Harvest no more than 20 million board feet per year averaged over the first 10 years of management plan implementation, and harvest no more than LTSY during any decade of the planning period used to calculate LTSY.

Reduce invasive weed species such as eucalyptus in favor of native vegetation. Increase conifer stocking on the east end of the Forest.

Achieve maximum sustained production of high quality forest products while maintaining, recruiting, or increasing other public trust resources.

Parameters and Data Collection, all goals:

Monitoring of many forest resources is tied to forest inventory measurements. Several inventory efforts are currently ongoing and will continue to be implemented. An intensive forest inventory (IFI) is conducted periodically as a part of the Forest's stand based forest inventory and vegetation typing system, and a continuous forest inventory (CFI) is periodically measured to assess growth and other changes. In this inventory process, timber as well as forest structure parameters are measured in detail. The following parameters are measured at regular intervals:

Table 5. Inventory Measurement Parameters.

Parameter	Unit	How Derived
Diameter	Tree	Measured
Species	Tree	Measured
Height	Tree	Measured
Health	Tree	Estimated
Crown length	Tree	Measured
Five-year increment diameter growth	Tree	Measured
Canopy position	Tree	Estimated
Canopy closure	Stand	Measured
Species mix	Stand	Measured
Average stand diameter	Stand	Calculated
Dominant understory vegetation	Stand	Estimated
Last treatment implemented	Stand	Recorded
Forest type / seral stage	Stand	Measured
Site quality	Stand	Measured
Connectivity of different forest types	Planning watershed, Forest	Calculated
Amount of edge, patch size, forest interior	Planning watershed, Forest	Calculated
Visual quality	Planning watershed, Forest	Calculated
Reforestation	Project	Measured
Release and thinning	Project	Measured
Timber harvest	Project	Measured

The continuous forest inventory (CFI) system has been measured at five to 10-year intervals since 1959, and provides a high quality historical record of forest growth and structure characteristics over a 45-year period. Forest-wide growth, stocking and structure characteristics will continue to be measured under the continuous forest inventory system.

Intensive pre- and post-harvest inventories will be conducted periodically on THPs to enable evaluation of the effects of silvicultural methods. These inventories will enable analysis of the effects of treatments such as structure retention.

Forest vegetation types are mapped for the whole Forest. The vegetation map is based on remotely sensed imagery (aerial photography) combined with ground truthing. It will be updated based on management treatments that occur, and new vegetation maps will be developed periodically, along with records of stand management.

Research projects will continue to contribute a wealth of data evidence to help characterize past, present and future conditions on the Forest. Research data will be captured in a comprehensive data base. All data will be made available to researchers and the public via the State Forest website and other means.

Analysis:

Analyses include standard statistics estimated from the IFI and CFI data include stand tables and stock tables, species distribution, and forest structure characteristics, including CWHR. The State Forest Data Bank, a data base that integrates existing forest inventory data, provides the ability to conduct ad hoc queries on any forest-related variable. GIS data will be linked to the data base to provide spatial reference. The forest structure characteristics data permit estimating seral stage and wildlife habitat values using for example the California Wildlife Habitat Relationships system.

Adaptive Management:

Implement silvicultural methods to create a mix of seral stages. Implement silvicultural methods aimed at cultivating late seral conditions in selected managed stands.

Reduce or increase annual harvest levels to achieve the desired five-year rolling average harvest levels and non-decreasing inventory levels.

Implement silvicultural methods that increase conifer site occupancy and selectively remove hardwood species where they are over-abundant.

Implement the guidelines from the JDSF Option A plan.

Sediment Sources

Hillslope conditions - mitigate road and crossing problem sites.

Parameters and data collection:

As part of the Road Management Plan for JDSF, CDF will survey all of the roads and crossings on JDSF over a 3-year period, identify problem sites, develop priorities for treating problems (inventory/baseline monitoring), and begin treating problems as expeditiously as budgets allow (perhaps we could state a minimum %age of annual revenue??). The procedures for the road and crossing inventory are described in detail in Appendix V. The inventory will include permanent, seasonal, temporary and abandoned roads and crossings. Once complete, the inventory will be regularly updated with information from continued road inspections, maintenance and monitoring.

Active roads and crossings will be inspected at least once annually to ensure that drainage facilities and structures are properly functioning (effectiveness monitoring). This monitoring will use a rapid ad hoc inspection procedure and will be a part of daily activities. More intensive inspection will occur every two years.

The analysis phase will consist of qualitative evaluation of problem areas using professional judgment.

Adaptive management approaches include treatment of problem sites and road maintenance. This is described in more detail in the Road Management Plan.

Hillslope monitoring – minimize erosion impacts resulting from forest management operations.

Parameters and Data Collection:

Parameters and data collection will include the following items for completed THPs (inventory/baseline, implementation, effectiveness monitoring): 1) inspection of all watercourse crossings, road segments, and landings, 2) map the location of rilling/gullying on road surfaces, landings, and watercourse crossing fills that are contributing significant amounts of sediment to watercourses, 3) map the location of mass failures (including cutbank/fillslope sloughing) associated with roads, crossings and landings, or within harvesting units observed during the completion of the other items described in this section, 4) map the location of road drainage structures (including watercourse crossings—existing and abandoned or temporary crossings) contributing significant amounts of sediment to watercourses, 5) when altered significantly by management, measurement of WLPZ overstory canopy for Class I and Class II watercourses, and 6) record information on the causes of the erosion features described above, proposed improvements needed, and a timeline to make these improvements. Information will be recorded as to whether the erosion feature was the result of the current timber operation (validation monitoring). THPs will have over-wintered 1-4 years.

Analysis will include examining relationships between forest management operations and documented erosion. Adaptive management solutions will be site specific based on established practices and professional judgment.

Minimize landslides associated with roads, landings and harvest units.

Parameters and Data Collection:

Parameters and data collection will consist of identifying landslides associated with roads, landings or harvest units by both direct observations in the field augmented with aerial photographs. These observations will be complemented with records of silvicultural prescriptions applied to the surrounding area in the past.

The analysis portion of the monitoring process will be separated into two classes of landslides: those associated with roads and landings and those that are not. As a part of the road inventory, all unstable areas observed along roads or landings will be identified following an approved inventory methodology. Mitigations will be based upon reviews by appropriate professionals, which may include RPFs, CEGs, LTOs, and maintenance crews. In-unit landslides that are not associated with roads or landings will be inventoried when encountered. On-going research by CGS certified engineering geologists involving mapping landslides associated with clearcuts may be expanded to address landslides in areas with other silvicultural prescriptions. Specific tasks may include but are not limited to: 1) compilation of data on road-related landslides, 2) compilation of landslide frequency, type, size, slope, relative activity, sediment delivery to a watercourse and relationship to past and current forest practices on slopes with similar characteristics, 3) Based upon the best available information, develop a more detailed map of landslides and relative landslide potential, 4) compare relative landslide potential map with field maps of landslides that fail, 5) compare field mapped landslides to areas of predicted low stability modeled by various computer models. Sets of aerial photographs for JDSF from the 1940s to the present will be used to aid in achieving the adaptive management goal to develop silvicultural prescriptions and road and landing construction techniques that minimize the risk of triggering landsliding.

The adaptive management solution to achieving this goal is development and application of silvicultural prescriptions and road and landing construction techniques designed to minimize the risk of shallow landsliding.

Instream Conditions and Fisheries

Stream channel conditions - maintain or improve aquatic and riparian habitat conditions and minimize sediment delivery to watercourses.

Parameters and Data Collection:

Surveys of stream channel conditions will be implemented for a limited number of streams on JDSF. These surveys will establish and/or contribute to a comprehensive set of baseline information. The data collected through these surveys will also be used to monitor long-term trends in channel morphology, habitat quality and woody debris, and to evaluate the effectiveness of prescriptions designed to maintain or improve aquatic and riparian habitat conditions and minimize sediment delivery to watercourses. The goals of this work are (1) to assess and monitor the quality and quantity of habitat available for the freshwater life history stages of coho salmon and steelhead, and (2) assess and monitor the trends and effects of sediment input and transport in JDSF's stream channels. If possible the surveys will use protocols consistent with those used in previous JDSF stream channel surveys. Methods will also be consistent with the current survey methods for woody debris and channel conditions in Caspar Creek and elsewhere on the Forest. The reaches sampled will be carefully documented and described so that they can be relocated and resurveyed. Parameters sampled will vary depending on the stream reach evaluated, but may include:

- LWD frequency by size class, with information on condition and placement
- Pool dimensions (including pool volume, residual pool depth, and useable rearing/holding/overwintering habitat)
- Pool frequency
- Gravel permeability, embeddedness and size distribution (including overall d50 of sampled reaches)
- Channel dimensions (measured using transects)
- Longitudinal profiles and cross sections
- Bank conditions and entrenchment
- Benthic macroinvertebrates

For analysis, data collected for these parameters will be evaluated against benchmarks such as those provided from the literature, relevant agencies, and the FEIR. Trends will be analyzed, including the examination of correlation and causation between changes in parameters and land management activities.

The adaptive management solution relative to this goal consists of developing and implementing a set of management prescriptions designed to maintain or improve aquatic and riparian habitat conditions and minimize sediment delivery to watercourses.

Minimize potential cumulative watershed effects resulting from forest management activities.

Parameters and Data Collection:

Parameters and data collection are defined by the research protocol in the ongoing Caspar Creek watershed study, the only long-term hydrologic record (44 years) from watersheds located in second growth conifer forests. On August 17, 1999, CDF and the USFS-PSW signed a Memorandum of Understanding (MOU) agreeing to a long-term philosophy of cooperation for conducting watershed research at Caspar Creek. It was agreed that for 100 years, the two agencies will continue to endeavor to: 1) measure streamflow at the North and South Fork weirs, 2) measure rainfall at two locations in the watershed, 3) maintain sub-watersheds H and I in the North Fork as untreated controls, 4) measure suspended sediment at the North and South Fork weirs and H and I sub-watersheds, and 5) maintain a 2.5 acre headwater swale in the North Fork as an untreated control for comparisons of pipeflow and subsurface hydrology with treated headwater swales.

Analysis approaches and adaptive management solutions will continue to evolve as a part of the Caspar Creek watershed study. Research projects are likely to continue to be the major source of both. Findings from the Caspar Creek watershed study and other research will be applied in the management of the Forest, as appropriate.

Stream temperature - maintain or improve current stream temperature regimes.

Parameters and Data Collection:

CDF has intensively monitored summer water temperatures in JDSF streams since 1993. Annual summer stream temperature monitoring is scheduled to continue. Stream temperature data currently reported for each location include: (1) hourly water temperature, (2) maximum 4-week moving average temperature and date of occurrence, and (3) maximum 7-day moving average temperature and date of occurrence.

Analysis will include the comparison of data collected for these parameters with benchmarks such as those provided from the literature, relevant agencies, and the FEIR. JDSF also will conduct trend analysis, including the examination of correlation and causation between changes in temperature, land management activities, and changes in stream canopy. Adaptive management solutions will consist of modifying forest management prescriptions and manipulating vegetation canopy cover as needed.

Maintain or improve current fish and amphibian populations on the Forest.

Parameters and Data Collection:

Since 1962 CDFG has maintained a weir and coho salmon egg-taking station in JDSF, located on the South Fork Noyo River near the confluence with the North Fork of the South Fork Noyo River. Each year CDFG attempts to count all of the returning coho at the weir.

The U.S. Forest Service's Redwood Sciences Laboratory conducted yearly electrofishing surveys in the North and South Forks of Caspar Creek between 1986 and 1995. The surveys documented density, biomass, and distribution of fish and amphibians by habitat type during the early summer.

CDFG traps and counts downstream juvenile migrant salmonids in mainstem Caspar Creek, approximately 1 mi (1.6 km) downstream from the confluence with South Fork Caspar Creek. The downstream migrant trap has been operated annually since 1987 from March through June.

Since 1986 CDFG has monitored the density of juvenile salmonids at two locations in mainstem Caspar Creek.

In summer and fall of 1995, 1996, and 1997 streams in JDSF were surveyed to identify the upstream extent of salmonids and document the species present. These surveys also documented the location of potential barriers to salmonid migration. Data was collected on large woody debris loading and fine sediment in stream gravels in Hare Creek.

CDF and DFG have periodically documented habitat type, fish biomass and density, amount of fine sediment, stream shading, and large woody debris loading in five reaches in the South Fork of Caspar Creek since 1992.

CDF will continue to work with its various partners to collect or to expand the collection of the above types of data.

When planning for timber harvest, selected large woody debris within stream segments will be inventoried to determine relationship to potential target levels.

Analysis will consist of summarizing available data and assessing fish populations. Adaptive management solutions are complex and need further work, but the same management strategies as used for stream temperature will apply.

Wildlife Resources

Many of the monitoring and adaptive management strategies for wildlife resources are described in detail for individual species in Chapter 3. This discussion covers overall strategies for a larger group of species.

Protect or improve current populations and habitat.

Parameters and Data Collection:

Raptors – CDF currently monitors selected Northern Spotted Owl activity centers on JDSF. CDF began surveys for the northern spotted owl on JDSF in 1989, with survey efforts increasing in the early 1990s. Banding of individual owls began in 1990 and continued intermittently through 1997.

CDF conducts northern goshawk surveys when suitable habitat is present within timber harvesting plans or other project areas. JDSF will develop and implement a training program to assist personnel in raptor identification, nest sites, and survey techniques on an as needed basis.

JDSF will conduct an annual aerial survey for osprey, depending upon the availability of a CDF helicopter and survey THP areas for osprey and other raptor species of concern (inventory/baseline monitoring). JDSF will conduct ground-based surveys (Northern Spotted Owl, Accipiters) using established or generally accepted protocols prior to project implementation. The survey will include suitable habitat within the project area and the largest disturbance buffer potentially established for proposed management activities.

Marbled murrelet - the U.S. Forest Service's Redwood Sciences Laboratory conducted the first survey for marbled murrelets on JDSF in 1988. No surveys took place between 1989 and 1992. Annual marbled murrelet surveys began in 1992 and have continued. Marbled murrelet surveys since 1992 have generally been conducted in accordance with established survey protocols for this species. Survey efforts have focused on potential suitable habitat within or near project areas (primarily old-growth groves; potentially, large, old individual trees with necessary structural characteristics) at various locations throughout JDSF.

Aquatic and riparian ecosystem dependent species of concern - current stream survey projects will continue (see previous section).

Snag and cavity dependent species of concern - snag and down log occurrence, density and size data is collected as part of JDSF forest resource inventories. CDF will supplement plot data with additional plots where necessary to provide a special habitat element assessment at the scale of a 40-160 acre drainage area.

Analysis will focus on species specific data trends, population and habitat models. Adaptive management strategies include modifying the timing, location and nature of management activities. These are described in more detail in Chapter 3 for individual species.

Plant Resources

Protect and restore the diversity of plant species across the Forest.

Parameters and Data Collection:

CDF will develop and implement a training program to assist personnel in sensitive plant identification

and habitat requirements on an as needed basis. A qualified botanist and/or trained forest personnel will conduct surveys based on the concepts contained in the DFG Guidelines for Assessing the Effects of Proposed Projects on Rare, Threatened, and Endangered Plants and Plant Communities (CDFG 2000) within project areas and areas of influence to assess plant occurrence as necessary (inventory/baseline monitoring). Surveys will include suitable habitat within the proposed project area and any suitable habitat off-site that may be affected by project implementation. Off-site areas include but are not limited to areas where hydrologic conditions could be altered through project implementation.

Survey summaries will form the basis for botanists' or foresters' professional judgment about possible adaptive management strategies. This may include modifying the nature and location of management prescriptions.

Recreation Resources

Improve the utility of the Forest as a recreation destination.

Parameters and Data Collection:

Visitor-use surveys will be conducted in the near future and at least every 10 years to ensure that the recreation facilities and opportunities provided meet users' needs. Adjacent landowners, including neighboring property owners, will be included in future studies on recreational uses in the JDSF as well as forest visitors, recreation user groups (e.g., local mountain biking groups), and people camping in the forest. The initial phase of the surveys will be informal focus groups with as many of the known types of recreational users to get direction on the main areas of current use and how to engage these groups in the design, implementation, and stewardship of a more extensive recreational facilities system.

JDSF will monitor environmental impacts of visitors to the Forest (including those incurred as a result of mushroom harvesting) by maintaining law enforcement reports and compiling annual summaries of maintenance projects associated with recreational facilities and activities.

Analysis of recreation data and adaptive management strategies will include the following:

Descriptions of significant nuisances will be recorded, compiled and reviewed annually, including, but not limited to, vandalism, littering, and noise. Additional restrictions will be implemented as needed.

Annual estimates of public use in visitor-days using camping permits, surveys and other information will be compiled and presented in the JDSF Annual Report. Information compiled will include where people have come from and how long they have used the State Forest, as well as identifying high-use weekends and preferred campsites. Use trends will be evaluated every five years to aid in determining if the opportunities provided meet the current demand as well as assisting in the design of visitor-use surveys.

A web site or specific link for Recreation on JDSF will be considered for future development. The web site could include the number of hits on various recreation topics and will provide information as well as an avenue for public comments. The web site would be updated and public comments reviewed. A review of the overall design would be conducted annually. Comments from the web site would be summarized and included in the five-year recreational trend review.

Minor Forest Products

Achieve a sustainable public use of the Forest and all its resources.

Parameters and Data Collection:

Staff will continue to monitor the collection of minor forest products on an annual basis. Permits are recorded and quantified annually. In the woods, staff will periodically check for valid permits and compliance with permit conditions and other Forest use restrictions.

Analysis of the data consists of simple summaries of quantity harvested of each minor forest product. Professional judgment will be used to devise adaptive management strategies to possibly limit harvest activities to sustainable levels. Law enforcement procedures will be adapted as needed to address trends in improper or illegal removal of minor forest products.

Heritage Resources

In its role as a demonstration forest, JDSF seeks to develop methods of enhancing and improving its heritage resource management program, and to prevent degradation or gradual depletion of resources such as that which can occur as a result of road maintenance practices and recreational activities.

Parameters and Data Collection:

CDF will establish a systematic monitoring program to evaluate the effectiveness of site protection practices during timber harvest operations. CDF archaeology staff should participate in completion inspections as time allows, to evaluate the effectiveness of site protection measures at the conclusion of project operations. A second alternative will be for JDSF staff to prepare a brief report specifically addressing observations on the effectiveness of site protection measures. When inadequacies are identified, appropriate remedial actions can then be developed and implemented.

The current heritage resource management program at JDSF has been largely successful in protecting sites during timber harvest operations. Some damage may have resulted from activities such as road maintenance, fires, and recreational activities (Betts 1999). Another potential impact is the depletion of surface artifacts. At some sites, the surface evidence is less than when these sites were originally documented, but the cause of this depletion is not known. Illicit artifact collection has been identified as a problem on the forest (Levulett and Bingham 1978). While sites are systematically inspected as part of project operations, there is no program in place to document non-project related impacts. During timber harvest operations, CDF Foresters examine sites during active inspections and at the completion inspection. The Forester is required to check the site protection measures, but would only notify the archaeology staff if a major problem was encountered.

Analysis and Adaptive Management Strategies:

CDF will develop a strategy to manage archaeological sites that are bisected by roads, or in close proximity to other projects and recreational sites, in order to mitigate impacts to sites caused by public use and regular road grading and maintenance activities. This plan should be developed by the Forest Manager in consultation with CDF archaeological staff. This plan should include procedures for identifying sites that could be impacted during road maintenance activities, stipulate protection measures for sites that could be impacted during these operations, and specify mitigation measures when impacts can not be avoided. Recognition should be given to the operational limitations and individual circumstances in which specific maintenance activities are carried out. Procedures should be developed in which impacts to sites can be evaluated on a case-by-case basis. Until this plan can be developed and implemented, road maintenance activities should be carefully monitored in the vicinity of all archaeological sites to prevent site damage. Ground fires with potential to damage sites will be excluded from site areas when possible.

Validation Monitoring

In addition to the JDSF approach to monitoring and adaptive management described above, JDSF supports numerous research projects that have provided valuable insights into possible cause-and-effect relationships between forest management activities and ecosystem structure. Validation monitoring as

part of an experimental design can incorporate a variety of additional data sets to support JDSF's monitoring efforts. Some of these studies include:

The research program carried out jointly by the USFS and CDF at Caspar Creek includes a variety of elements designed to evaluate hydrologic, erosion, and sediment impacts associated with road building and logging:

- Continuous measurement of streamflow and suspended sediment at two gauged weirs in the North and South Forks of Caspar Creek since 1962.
- Annual measurement of sediment accumulation in the weir basins at the North and South Fork stream gages.
- Measurement of precipitation at 2 gages in the North Fork, one in the South Fork and one at Fort Bragg. The gages are equipped with event recorders to record time and rainfall amount in increments of 0.01 inches.
- Measurement of discharge and sediment load at six sub-watersheds in the North Fork from October-April, in addition to the North and South Fork gages. Bedload is measured only during large storms.
- Measurement of channel morphology in selected reaches, every three to five years, after exceptionally high flows. This includes cross sections, pool inventories, and V* (volume of fine sediment in pools).
- Measurement of LWD loading in the North Fork.
- A study of tree blowdown in riparian buffer strips and its effect on the supply of LWD to streams.
- A study of soil pipe flow and soil pore water pressure.

The USFS Redwood Sciences Laboratory and CDF have jointly drafted a long-term research plan for the Caspar Watershed study. The proposed research plan includes a long-term study of recovery following logging in the North Fork, and continued monitoring of factors related to sediment transport and hydrology at the North Fork and South Fork weirs.

In addition to the research program at Caspar Creek, validation monitoring has included:

- Habitat inventories and field inspections by CDFG have indicated that habitat for juvenile steelhead and coho salmon in many JDSF streams would benefit from the addition of LWD to the channel. In fall 1996 CDF, in cooperation with CDFG, placed LWD in a reach of Parlin Creek and is now monitoring the effects of LWD addition on pool depth, complexity and frequency. The study was extended in the summer of 1999 to include placement of woody debris in Hare and Caspar Creeks and monitoring of effects. As part of an experiment on the effects of enhancing large woody debris (LWD) in JDSF streams, CDFG is monitoring habitat for juvenile salmonids at sites in Parlin, Hare and Caspar Creeks.

- The National Marine Fisheries Service (NMFS) in cooperation with the California Department of Fish and Game (CDFG) has begun a study on straying and homing rates for coho salmon in the Noyo River drainage using mark and recapture techniques. The purposes were: 1) to estimate straying and homing rates for coho salmon; 2) to estimate rates of movement of juveniles within and between drainages; 3) to improve estimation methods for returning adults; and 4) to identify the nature and degree of interaction between naturally-produced and hatchery adults on spawning grounds. The study includes downstream migrant trapping of juvenile coho salmon at two locations in the South Fork Noyo River basin within JDSF, and carcass counts and redd mapping at numerous locations in the basin.

Funding

All monitoring activities will be reviewed annually to coincide with a report on monitoring presented in the JDSF annual report. The funding of monitoring activities will be accomplished via timber sales where appropriate, and special fund contracts. The annual JDSF and statewide budgets for research,

demonstration, and monitoring are other sources for funding. A proposal for acquiring monitoring funds shall be submitted to Sacramento following the annual review. It will include a prioritized list of monitoring activities with their costs. Allocation of funds will be balanced against research and demonstration needs and the monitoring needs of other state forests. Planned future monitoring activities to a large extent can be folded into other research or operations projects such as resource inventories.